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THE EFFECT OF AUDITORY DISTRACTION UPON THE SENSORY REACTION[1]

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The effect upon reaction-time of intercurrent or 'distracting' stimuli has been variously reported. Most frequently the 'distraction' serves to lengthen the time; but sometimes it decreases it; and occasionally, after a brief initial disturbance, it leaves the time unaffected. No explanation can be found, so far as the published researches go, in the nature of the distractors as simple or complex, of this sense-modality or of that. It is possible, however, that their temporal relations are significant. Most of the distractors, in the experiments that showed an increase of the reaction-time, were irregular and intermittent; all of the distractors, in the experiments that showed a decrease or no change, were regular and continuous. This generalization is obtained by the comparison, not of different experimental series within a single investigation, but of separate investigations: in so far, and apart from the fewness of the investigations themselves, it is subject to doubt. It seemed worth while, nevertheless, to examine the effect upon the simple sensory reaction-time of distractors which vary widely in their temporal aspects. This is the specific object of the present study. We believe also, from a review of the experimental work done under 'distraction,' that many studies of the same special sort must be undertaken before the general question can profitably be discussed.

We employed three distractors: one that was continuous

[1] From the Psychological Laboratory of Cornell University.

throughout the entire period of the experiment, *i. e.,* during the intervals of introspective report and of rest as well as during the reactions proper; another that was intermittent, beginning just before and continuing through the reaction; and another that was continuous for a set of ten reactions, but was interrupted during the periods of introspective report and rest. We shall term them henceforth the 'continuous.' the intermittent,' and the 'continuous-intermittent' distractors.

Observers. The observers were Miss A. Luce (L), and Mr. A. M. Palmer (P), advanced students in psychology; Dr. G. J. Rich (R), graduate fellow in psychology; and K. M. Dallenbach (D). L, P and R were unfamiliar with the object of the research and with the method of the reaction experiment; D was familiar with both. R and D served throughout the experiment; P began to observe in Jan., 1917, and withdrew from the University in April; L served only during the preliminary period of training.

Apparatus. Two rooms at opposite ends of the laboratory were used for the experiment. The experimenter, with the Hipp chronoscope and its accessories, was in the one room and the observer, with the stimulating and reacting apparatus, in the other.

The chronoscope was operated from make to break, and was controlled by Wundt's large control-hammer, in turn controlled by the Wundt chronograph. The control-hammer varied, according to the chronographic records, less than one five-hundredth. The average for a series of ten readings was 198 ± 0.36 σ. The chronoscope varied, according to the control hammer, less than one one-hundredth. This small variation was obtained by a careful adjustment of the springs and current that operated the magnets. The current was obtained from six dry cells wired in series. The strength of the current was kept constant by the aid of a resistance box and a rheochord. With the magnet springs in a fixed position and the current at 3.5 volts and 62.5 milliamperes, the constancy above stated could be obtained for any series of readings of the fall of the control-hammer.

The observer's room was darkened, in order that he might be free from visual distraction. The stimulus was the noise produced by the Wundt sound-hammer, which was placed directly in front of the observer at a distance of 40 cm. As in Evans' experiments,[2] the hammer was so adjusted that the only sound produced was from the impact of the hammer on the anvil. The ordinary 'telegraph' form of key was employed. The key was fastened to the table at a convenient distance to the right and in front of *O*. The forefinger was laid upon the edge of the button. Since a pressure of 400 gr. was necessary for contact, *O* exerted a slight pressure in order to hold the key down. The reaction was made by snapping the finger from the button.

Two flashes of light from a 2.9 volt electric globe were given before every experiment as the 'ready', 'now' signals. Their intensity was greatly reduced by four layers of black cloth. The globe was placed upon the wall in front of *O*, at a distance of 50 cm., and at the level of his eyes. The first flash, the 'ready' signal, was set to occur 3 sec., and the second, the 'now' signal, 1½ sec. before the occurrence of the stimulus. As timed by the Hipp chronoscope they occurred

[2] Evans, J. E., *Archives of Psychology,* XXV, 1916, No. 37, p. 15.

3265 ± 32.6 σ and 1853 ± 11.8σ respectively before the stimulus. The first flash lasted 695 ± 4.7σ and the second, 706.8 ± 2.8 σ. These preparatory signals were automatically operated by the Meumann time sense apparatus and the Ludwig-Baltzar kymograph; the apparatus were in *E*'s room and were controlled from his desk by an electrical switch.

Procedure. The first problem was to familiarize the observers with the apparatus, and to train them in the mode and method of response. Directions for the sensory reaction were read to them at the beginning of every hour throughout the period of training.

The length of this period differed for the different observers. It was continued, except in the case of L, until the m. v. of any series of ten reactions was well below 10% of the average.

Although the reactions were computed in series of ten, every one was timed and separately noted; so that if a movement was made prematurely, or occurred under accidental disturbance, etc., the datum could be omitted and the experiment be repeated. The observer designated the occurrence of such faulty reactions by a push upon a bell-button which was on his desk at the right of the reaction key, and which was connected with an electrical buzzer in the experimenter's room.

After every ten reactions *O* wrote an introspective report, which was used primarily as a check upon his mode of reaction. If it indicated that his response tended to be 'muscular', the instructions were re-read: if it showed that they were sensory, the next series was given without further delay.

In the early part of the practice-period only 50 reactions (5 series) were made in an hour. As the observers became more proficient, more reactions were made; and finally 100 reactions (10 series) were obtained at one sitting. During this preliminary training L gave, in all, 173 series; P, 71 series; R, 74; and D, 46.

In the effort to obtain the required constancy of reaction, L's training, as is shown above, was continued far beyond that of the other observers. To no avail, however: for her deviations were nearly as large at the end as they were at the beginning. We give below the data of 10 consecutive series from the early part of training, and of the 10 series taken on the last day of training.

Series from Early Part of Training			Series from Last Day of Training		
Series number	Av. Reaction-time	m. v.	Series number	Av. Reaction-time	m. v.
21.	327.5	92.10	164.	234.8	48.48
22.	321.1	83.06	165.	257.0	54.40
23.	366.2	34.54	166.	276.4	37.80
24.	252.1	63.20	167.	283.5	41.20
25.	314.5	53.10	168.	312.4	38.86
26.	294.0	40.40	169.	307.0	40.20
27.	287.7	38.08	170.	294.3	47.30
28.	262.6	40.20	171.	299.5	37.40
29.	244.5	94.10	172.	318.0	32.00
30.	302.7	55.80	173.	261.8	55.14
Average	297.29	59.46		284.47	43.27

It was evidently impossible for L, under our instructions, to maintain a constant attitude; and her service in this problem therefore ended with the practice-series.

Distractors. A metronome beating 120 in the minute was used as the 'interrupted-continuous' distractor. It was electrically controlled from the experimenter's desk, so that it could be released and checked before and after every distraction-series.

An electric bell was used as the 'intermittent' distractor. It was automatically controlled by the time-sense apparatus. Contact was made after the "Ready, Now" signal, about 1 sec. before the stimulus, and lasted for 2.5 sec. As timed by the Hipp chronoscope, the bell began ringing 1182 $\pm$ 10.9 σ before the sound of the stimulus, and continued for 2584.9 $\pm$ 19.8 σ.

An electrically driven tuning-fork of 256 vs. was used as the 'continuous' distractor.

Plan of the Experiment. The 'interrupted-continuous' distractor, the metronome, was first employed. During these experiments the three *O*'s served three times a week; 8 to 12 series, according to the length of time needed for the introspective reports, were obtained at a sitting. In the early part of the work, the experiments were so arranged that 4 normal series were taken with every 10 distraction series; later the number of normal series was reduced to 3. The normals were distributed equally often, in every case, to the first, second, third, fourth, etc., places. The work continued under these conditions until R and D had completed 100 series (1000 reactions) with distraction, and 34 and 33 series respectively of the normal type; and until P had completed 59 series with distraction and 29 normal series.

Next the 'intermittent' distractor, the bell, was used. The observers, R and D, served five times a week. Twelve series of reactions were obtained during every hour; only the first and last of these were control series. At the end of two weeks, when 100 distraction series and 20 control series had been obtained, the third distractor was employed.

With the 'continuous' distractor, the tuning-fork, 14 series were obtained during a single hour. The first 5 were distraction series, the next 4 control series, and the last 5 were again distraction series. The observers served five times a week; so that, at the end of a fortnight, 100 distraction series and 40 control series had been obtained.

TABLE II

Average and Mean Variation of the Reaction-times under Distraction and under Normal Conditions

Mode of Distraction	OBSERVER			
	P			
	Distraction series		Control series	
	Av.	m. v	Av.	m. v.
1. Interrupted-continuous	192.79	23.73	173.80	20.43
2. Intermittent	......	......	......	......
3. Continuous	......	......	......	......

TABLE II—Continued

Mode of Distraction	OBSERVER R			
	Distraction series		Control series	
	Av.	m. v	Av.	m. v.
1. Interrupted-continuous	254.38	37.20	243.11	35.00
2. Intermittent	273.48	31.07	236.14	23.46
3. Continuous	264.65	22.48	255.78	21.35

TABLE II—Continued

Mode of Distraction	OBSERVER D			
	Distraction series		Control series	
	Av.	m. v	Av.	m. v.
1. Interrupted-continuous	206.12	24.85	201.73	23.59
2. Intermittent	220.27	27.65	203.68	21.14
3. Continuous	219.92	21.62	217.46	20.52

The general averages and the mean variations of the reaction-times, under the three modes of distraction and under control conditions, appear in Table II.

The reactions taken under distraction are longer, and their mean variations are larger, than is the case under normal conditions. This relation is constant for all three observers for all three modes of distraction, though the amount of difference, as is shown below in Tables III and IV, varies with the mode of distraction.

TABLE III

The Difference, the Probable Error of the Difference, and the Probable Correctness of the Difference between the Average Reactions under Distraction and those under Normal Conditions.

Mode of Distraction	OBSERVER					
	R			D		
	Dif.	P E.	P. C.	Dif.	P. E.	P. C.
1. Interrupted-continuous (metronome)	11.27	1.975	100.00	4.39	1.280	98.97
2. Intermittent (bell)	37.34	1.628	100.00	16.59	1.528	100.00
3 Continuous (tuning-fork)	8.87	1.231	100.00	2.46	1.039	94.55

TABLE IV

Difference in Mean Variation of the Reactions under Distraction and under Normal Conditions

Method of Distraction	Observer	
	R	D
1. Interrupted-continuous (metronome)	2.00	1.26
2. Intermittent (bell)	7.61	6.51
3. Continuous (tuning-fork)	1.13	1.00

Tables III and IV show the differences, for the three modes of distraction, in length of reaction-times and in size of their mean variations. These differences are smallest in the case of 'continuous,' and largest in the case of 'intermittent' distraction: the ratios are approximately 1.0:1.5:5.0. The uniformity of the results leads us to conclude *that the 'inhibiting' effect of a distractor varies with its duration and regularity.*

It might be thought that the inhibitory effect is dependent upon the qualitative as well as upon the temporal differences. But (1) in no investigation so far published does the effectiveness of distractors of even greater qualitative difference vary by so great an amount. And (2) D has found, in an attempt to obtain a graded series of distractors, that qualitative difference within a modality has very little if anything to do with the distractive effect.

Table III shows further the probable errors[3] and probable correctnesses[4] of the differences between the two sets of reaction-times. The probable errors are small, and the probable correctnesses are either of mathematical certainty or approach that limit.

Were we to summarize our results at this point, following the example of certain experimenters in the past, we should be led to conclude that the effect of the distractors is constant, and always in the direction of an increased reaction-time. This conclusion is, however, not borne out by the facts obtained from a fractionation of the data. Tables V, VI, and VII show the detailed results for the three modes of dis-

[3] Computed by the formula: $\text{P.E.}_{\text{diff. A-B}} = \sqrt{(\text{P.E.}_{\text{A}})^2 + (\text{P.E.}_{\text{B}})^2}$. The probable errors of the averages were obtained by the formula: $\text{P.E.}_{\text{M}} = \frac{0.8453}{\sqrt{n}}\ \text{m.v.}$ Evans (*op. cit.*, 35) says that he calculated his probable errors by the formula $\text{P.E.} = \frac{0.8453\ \text{M.V.}}{n}$. We assume that the omission of the radical is a printer's error.

[4] See Boring, E. G., *Amer. Jour. of Psych.*, XXVII, 1916, 315-319; also XXVIII, 1917, 454-459.

TABLE V

Times of Sensory Reaction under 'Interrupted-continuous' Distraction (Metronome sounding only during a series) and under Normal Conditions, and Ratios of these Times

Groups of Reactions	Observer P					Observer R					Observer D				
	Distraction series		Control series		Ratio	Distraction series		Control series		Ratio	Distraction series		Control series		Ratio
	Av. Re-action Time	m. v.	Av. Re-action Time	m. v.		Av. Re-action Time	m. v.	Av. Re-action Time	m. v.		Av. Re-action Time	m. v.	Av. Re-action Time	m. v	
1	170.63	20.4	151.75	14.4	1.124	196.92	22.61	207.65	31.22	0.948	233.33	25.53	207.85	20.62	1.122
2	179.68	24.6	158.55	18.0	1.133	258.68	34.42	245.60	36.08	1.052	240.41	22.00	217.65	15.12	1.104
3	188.70	18.4	160.25	10.3	1.177	259.85	35.96	244.07	38.46	1.064	194.98	17.26	190.27	21.01	1.024
4	194.17	17.9	181.95	19.6	1.067	213.83	30.39	230.66	30.18	0.927	203.41	22.69	195.33	24.74	1.041
5	228.05	29.3	211.60	22.8	1.078	259.60	30.24	262.00	31.05	0.990	212.36	21.67	202.52	24.98	1.048
6	203.48	16.7	177.12	12.3	1.149	242.75	46.99	240.27	35.61	1.011	195.82	21.95	169.12	13.74	1.157
7	194.93	25.7	165.87	17.8	1.175	238.02	32.52	242.15	23.67	0.941	210.57	20.30	205.95	20.44	1.022
8	184.77	16.1	160.95	11.1	1.147	271.57	27.77	250.30	27.18	1.084	209.98	16.42	196.70	10 65	1.067
9	183.77	15.7	157.90	9.7	1.163	277.83	31.93	246.65	26.78	1.126	202.43	17.03	212.15	16.55	0.958
10	193.27	22.1	170.70	16 7	1.132	271.68	32.45	220.85	21.16	1.230	175.71	15.91	190.80	16.54	0.920
11	....	....	....	....	....	242.41	26.69	243.25	19.59	0.996	214.91	20.60	218.95	23.10	0.981
12	....	....	....	....	....	260.64	27.90	243.65	33.07	1.069	201.01	15.47	191.50	9.38	1.049
13	....	....	....	....	....	254.24	23.31	238.80	14.76	1.064	211.01	15.89	211.85	10.46	0.996
14	....	....	....	....	....	255.56	25.26	235.65	24.15	1.084	....	....	....	....	....

traction. The daily averages of the reaction-times for the distraction series and the control series, and the ratios of these averages, are shown opposite the numerals which appear in the first column under the caption " Groups of Reactions."

TABLE VI

Times of Sensory Reaction under 'Intermittent' Distraction (bell ringing just before and during reaction) and under Normal Conditions, and Ratios of these Times.

Groups of Reactions	Observer									
	R					D				
	Distraction series		Control series		Ratio	Distraction series		Control series		Ratio
	Av. Re-action time	m. v.	Av. Re-action time	m v.		Av. Re-action time	m. v.	Av. Re-action time	m. v.	
1	287.35	31.3	260.95	20.4	1.101	237.94	27.4	207.50	18.8	1.146
2	282.11	28.2	234.25	17.3	1.204	209.59	23.7	196.05	17.2	1.069
3	265.31	31.7	228.35	24.1	1.161	205.61	20.5	201.60	21.4	1.019
4	259.51	27.9	239.40	25.5	1.084	241.25	22.4	210.90	15.1	1.143
5	278.60	29.6	226.35	22.1	1.230	227.96	24.9	195.35	21.7	1.166
6	258.62	30.3	240.70	26.1	1.074	216.67	20.7	218.30	22.7	0.992
7	284.63	40.3	259.40	30.0	1.097	208.83	20.6	201.40	20.1	1.036
8	284.89	26.62	243.55	17.8	1.169	194.03	18.5	177.85	20.1	1.090
9	267.10	26.82	232.20	17.6	1.150	237.63	26.1	223.50	15.9	1.063
10	286.65	28.53	196.55	22.9	1.458	227.11	20.8	204.40	26.0	1.110

TABLE VII

Times of Sensory Reaction under 'Continuous' Distraction (tuning-fork sounding during periods of reaction and of rest) and under Normal Conditions, and Ratios of these Times.

Groups of Reactions	Observer									
	R					D				
	Distraction series		Control series		Ratio	Distraction series		Control series		Ratio
	Av. Re-action time	m.v.	Av. Re-action time	m.v.		Av. Re-action time	m.v.	Av. Re-action time	m.v.	
1	282.44	29.3	254.80	26.7	1.108	230.44	16.9	236.40	18.4	0.974
2	262.04	23.7	270.40	21.5	0.972	217.93	21.3	198.20	21.6	1.099
3	255.61	26.6	257.95	26.0	0.990	215.05	27.0	214.90	21.2	1.000
4	266.20	26.1	265.30	25.8	1.003	202.25	21.0	208.15	16.1	0.971
5	238.48	21.7	245.10	21.0	0.964	207.60	20.7	208.97	20.8	0.993
6	256.60	23.2	240.57	24.3	1.066	225.71	17.6	217.40	18.1	1.038
7	260.55	21.5	210.50	21.5	1.237	217.04	17.3	221.90	18.5	0.978
8	275.83	24.2	287.70	24.8	0.958	222.56	17.0	215.90	14.0	1.030
9	267.02	27.3	258.30	24.2	1.033	233.98	14.3	238.60	13.8	0.980
10	281.31	23.2	267.70	23.1	1.050	226.69	16.1	220.75	17.5	1.026

These tables show that no distractor operates constantly, or always in the same direction. The variability is large, and extends (with but a single exception) both to the positive and

to the negative sides. Table VIII gives the frequency of this alternation for both observers under the three modes of distraction; *i. e.*, shows the number of days on which the average distraction-reaction was greater and less than the average normal reaction.

TABLE VIII

Number of Days on which the Average Distraction-Reaction was Greater and Less than the Average Normal Reaction

Method of Distraction	Observer R Greater	Observer R Less	Observer D Greater	Observer D Less
1. Interrupted-continuous (met.)	9	5	9	4
2. Intermittent (bell)	10	0	9	1
3. Continuous (tuning-fork)	6	4	5	5

Though in case 2 R offers an exception to the rule that 'distraction' sometimes facilitates reaction, the variability of the ratios has a wider range for this distractor than for the other two. It extends from 1.074 to 1.458; whereas for the metronome it is 0.927 to 1.230, and for the tuning-fork 0.958 to 1.237.

These results, which corroborate those of Evans,[5] show the

[5] *Op. cit.*, 36-40; 72-80. Evans' six observers all gave instances of facilitation. A's reaction to light, under a light-distraction, was inhibited 20 times and facilitated 19 times (Evans, p. 36, says 18 times; but the table, p. 72, shows 19); under a sound distraction was inhibited 9 times and facilitated once; and under a touch-distraction was inhibited in all 10 times. B's reaction to light, under light-distraction, showed 16 cases of inhibition and 3 of facilitation; under sound-distraction, 4 cases of inhibition and 4 of facilitation; and under touch-distraction, 7 cases of inhibition only. Observers C and D reacted to a sound-stimulus. For C, only 2 of the 37 cases of sound-distraction, and none of the 9 cases of light or the 7 cases of touch-distraction, showed facilitation. D showed facilitation in only 1 out of 17 cases of sound-distraction. (Evans, p. 24, says that the reaction to a sound-stimulus with sound-distraction was followed, in the cases of C and D, by reaction to sound with light-distraction, and then by reactions to light with touch-distraction. The results for D's last two sets of reactions are not quoted; and the table p. 76 that gives C's results for the last set of reactions shows that the stimulus was a sound instead of a light.) The results of observers E and F more nearly parallel our own; for these observers were trained in the method of reaction with a view to elimination of the effect of practice from the distraction-series. E, under sound-distraction, gave 10 cases of inhibition and 1 of facilitation; under light-distraction, 9 cases of inhibition and 5 of facilitation; and under touch-distraction, 5 cases of inhibition and 4 of facilitation. F, with a sound-distractor, gave 9 cases of inhibition and 1 of facilitation; with a light-distractor, 3 cases of inhibition and 4 of facilitation; and with a touch-distractor, 4 cases of inhibition and 3 of facilitation.

fallacy of arguing from averages. The effect of distraction is equivocal; it sometimes increases and sometimes decreases the reaction-time.

Evans regards the reactions that show 'facilitation' as exceptional and atypical cases, due to lack of interest, poor adaptation, overtraining, staleness, confusion, inattention, and chance. He therefore omits them from consideration, and concludes that "the distractions were true distractions," which "affected the reactions by making the time longer."[6] The omission of these data does not, however, follow logically from the explanation offered of them; the explanation suggests rather that the effect of distraction upon reaction is dependent upon the observer's attitude.

That the 'exceptional cases' should not be omitted is shown, indeed, both by the frequency of their occurrence in Evans' and our own results, and also by the fact (Tables V, VI, VII) that their probable errors are as small and their probable correctnesses as large as those of the cases that indicate inhibition. For the sake of brevity, we give the actual figures of only one *O* under one distractor. We choose the instance of D in Table VII, where the distraction of the tuning-fork brought about an equal number of cases of inhibition and facilitation. The differences between the daily averages of the distraction series and the control series, the probable errors, and the probable correctnesses of these differences, are set forth in Table IX.

TABLE IX

Differences between D's Daily Averages under the Distraction of the Tuning-Fork and under Control Conditions, with the Probable Errors and the Probable Correctnesses of these Differences

Groups	Dif.	P. E. Dif.	P. C. Dif.
1	—5.96	2.861	92.07
2	+19.73	3.415	100.00
3	+0.15	3.658	51.07
4	—5.90	2.803	92.17
5	—1.37	3.309	60.89
6	+8.31	2.857	97.47
7	—4.86	2.895	87.14
8	+6.66	2.373	97.09
9	—4.62	2.217	91.97
10	+5.94	2.723	92.92

The one set of figures is plainly as valuable as the other; neither may be neglected. In other words, the data are heterogeneous: a conclusion confirmed by Tables V, VI and VII, which prove that the differences between the two kinds

[6] *Op. cit.*, 40, 53.

of reaction from day to day are greater than the differences for a single day. The daily averages, on the other hand, are homogeneous, as the small variations clearly show.[7]

We cannot take recourse to the effect of practice. That this effect was eliminated is shown implicitly by Tables V, VI and VII, and explicitly by Table X. This table gives the averages and mean variations found in both halves of the experiments for each observer under every mode of distraction. The values appearing under 'Distraction' are the averages and mean variations of 500 reactions; the number of reactions represented in the values under 'Control' varies. With the 'interrupted-continuous' distraction, the value for the first half was obtained from 190 reactions for R and 180 for D; that of the second half from 150 reactions in each case. The values for the other two modes of distraction were derived from 100 and 200 reactions respectively.

TABLE X

Averages and Mean Variations of the Distraction and Normal Reactions for the Halves of the Experiments

Modes of Distraction	Observer							
	R				D			
	Distraction		Control		Distraction		Control	
	1 half	2 half	1 half	2 half	1 half	2 half	1 half	2 half
Inter.-Con. (Metronome)	247.11 ±30.25	261.63 ±26.91	248.23 ±32.63	238.23 ±25.13	210.21 ±20.43	201.55 ±17.18	200.80 ±20.08	202.17 ±15.17
Intermittent (Bell)........	274.37 ±29.76	276.38 ±30.55	237.86 ±23.89	234.48 ±22.90	224.47 ±23.76	216.85 ±21.32	202.28 ±18.85	205.09 ±20.97
Continuous (Tuning-fork)	260.95 ±25.48	268.26 ±23.88	258.71 ±24.20	252.95 ±23.58	214.65 ±23.30	225.19 ±16.46	213.32 ±19.62	222.91 ±16.36

The first halves of the distraction-series are, with all three modes of distraction, shorter for R than the last halves. The relation is so constant, and the differences and the probable correctnesses of the differences are so large, that we have evidence not only that practice was eliminated, but also that there was a change of attitude, from interest to boredom. The control series, it is true, seem at first inspection to show the effect of practice; the second halves are shorter than the first. It is to be remembered, however, that the control series were taken less frequently than the distraction-series. We

[7] The mean variations given in these tables (Tables V, VI, and VII) are not the averages of the mean variations of the ten series, but are the mean variations from the averages of 100 reactions.

may infer, then, that on the introduction of the various modes of distraction, R was interested in the new conditions imposed upon him. After 500 or more reactions under the same conditions, his attitude changed; he reacted less efficiently. At first, while R was interested in the reactions, a change from distraction to control did not greatly affect the reaction: the averages of the first halves of the distraction and control series are very close. As habituation and tedium set in, the change from distraction to control became more and more marked; until the control reactions, in contrast with the monotony of the distraction-reactions, were performed more efficiently.

The results for D are the exact converse of those for R. Where R shows an increase in the average reaction, D shows a decrease, and contrariwise. The explanation given for R's results will not hold for D's, though we find in D's results evidence of the same change, habituation and consequent shift of attitude. This evidence is presented, first, by the control series, the averages of which show a steady increase with the advance of the experiment; and secondly by the large and sudden increment in the averages, under the third mode of distraction, of both the distraction and the control series.

These external indications of change of attitude should be borne out by the observers' introspective reports. These reports, excerpts from which follow, do in fact confirm the external evidences, substantiate Evans' suggestion, and enable us to account for the equivocal results of distraction and the heterogeneity of our data.

R reports, on the day on which the bell showed the greatest effect of inhibition: "The bell seems to make the reactions more difficult, seems to make the sounds come into consciousness more slowly. Am confused"; and on the day on which it showed the least effect: "Sometimes the two kinds of series [the control and the distraction] seem exactly alike, while at other times they seem so entirely different as to be incomparable. Today they seem alike, that is, I 'feel' that my preparation is the same and that I am giving the same sort of reaction in each."

D reports, when the bell was objectively most effective: "The bell occupied the focus of consciousness; seemed like a blanket spread over all other processes. . . . . the reaction was confused and unsteady"; and on the day when it was objectively least effective (*i.e.*, produced a facilitating effect): "During the distraction-series attention was concentrated on the sound of the stimulus; the bell did not bother me, but actually kept my mind closer to the task. The sounds of the stimulus were as clear during the distraction-series as during the control, where attention was discursive. Seemed unable to inhibit certain associative trains during the control series, whereas they were inhibited more or less involuntarily during the distraction-series."

R reports, during the first series of experiments under distraction by the metronome (the series that gave a ratio of 0.945): "At first I found that the distraction of the metronome upset my determination for sensory reaction, and I think I tended to give muscular reactions. The metronome is very unpleasant." That he did give a different kind of reaction is shown, in comparison with the normal and the other distraction-series that followed, by the extremely low average for that day. He reports after a normal series on the second day (ratio of 1.052): "The reaction without the metronome seems to be more passive than with it. When the metronome is sounding, I have actively to attend away from it. When it is not going, I just take the stimuli passively, and react to them as they come." After a distraction-series on the 6th day (ratio of 1.011): "While there is still some effort necessary to attend away from the metronome, this effort is getting less. In this series, my attitude was only slightly different from that of the preceding [a normal series], yet it was more effortful, more active." And again, after a normal series on the 11th day, when the distraction and the normal series were practically equal: "I cannot notice any difference between these reactions and those with the metronome going. I try to take them all in a passive attitude, just waiting until the stimulus comes without straining for it"; and after a distraction-series on the same day: "I seem to fall quite naturally into the 'set' for reacting with the metronome. It 'feels' natural, and I cannot see that it distracts me. On the contrary, it is rather a steadying agency. In the preparatory interval, its sounds drop out of consciousness."

On the sixth day of the distraction with the metronome, the day with the greatest ratio of the metronome series, D reported after a distraction-series: "Attended actively to the sounds of the hammer, which, when they occurred, varied from clear to very clear. The sounds of the metronome were ever in consciousness. They were rather insistent, varying from vague to clear, and at times becoming maximally clear." On the tenth day, the day with the smallest ratio of the entire series (0.92), D reports after a distraction-series: "Attended passively to the sounds of the hammer, and when they entered consciousness they were maximally clear. The sounds of the metronome were vague during the interval between experiments, and at the times of reaction they were totally obscure."

R reported after a distraction-series during the first observation under distraction by the tuning-fork: "The fork tends to attract my attention. Some effort is required to attend away from it. As a result I attended more to the reactions, and the only thing present in the fore-period to be attended to is the kinaesthetic strain sensations." On the fourth day, when the averages of the control and distraction series were about the same, he reports after a control series: "The stoppage of the fork seems to have no effect. The attitude is just the same with it as without," and on the fifth day: "The fork is not in the least a distraction. It makes no difference in the reactions." Again on the seventh day, the day that shows the greatest difference between the distraction and control reactions, R reports after a distraction series: "Am very sleepy, the monotonous hum of the fork increases the feeling."

D reports after a distraction-series during the first observation under distraction by the tuning-fork: "The tuning-fork very vague, most of the time it is obscure. The sounds of the hammer are maxi-

mally clear. Attended passively and without effort"; and after a distraction-series during the last observation: "The sounds of the hammer were maximally clear; all other processes, in background of consciousness, were vague and obscure."

We have, then, abundant evidence that the attitude of the observers was not constant. It changed from the distraction to the control series, and from day to day. It is only roughly correlated with changes in reaction-times. The correlation, however, is sufficiently close to allow us to conclude that *the effect of a distractor upon the sensory reaction is dependent upon the conscious attitude of the moment.*

We have no adequate data whereby to correlate the different attitudes and the rates of reaction under the conditions of distraction and control. Our observers were not instructed to report upon attitudes, and the information they gave was merely incidental. Since one of the experimenters was serving also as observer, the results were not worked over until the completion of the experiment, and we did not discover the significance and desirability of a report of attitude until it was too late to rectify the omission. From such data as we have, however, it seems reasonable to suppose that the distractors have no effect upon sensory reaction under a passive attitude, while they lengthen the time of reaction under an active attitude. The clearer, the more 'conscious' the distractor, the more active is the observer's attitude, and the more do the reactions differ from the normal; the more obscure, the less 'conscious' the distraction, the more passive is the observer's attitude, and the less does the reaction differ from the normal.

The bell showed the greatest effect of inhibition. The attitude in every case except one was more active during the distraction-series than during the control series; the reaction in every case except one was longer for the distraction-series than for the control. The exception (which we have noted) occurred in D's sixth observation. The apparatus on this day was found broken, and D was obliged to repair it before turning to the observation. During the experiments that followed, thoughts of the apparatus kept intruding themselves. D reports: "I seemed unable to inhibit certain associative trains during the control series, whereas they were inhibited more or less involuntarily during the distraction-series." The distraction 'facilitated' because, under these conditions, a more constant and more passive attitude was maintained than was possible under the conditions of the control series. Even here, therefore, where we have facilitation, we find that conscious attitude will account for the results.

The tuning-fork showed the greatest effect of habituation. After only a few experiments, both observers reported that the sound was very obscure, and that the attitude was practically the same for the distraction-series as for the control series. The differences between

the reactions are no greater than those between the various distraction-reactions, or those between the various control reactions; so that the reaction-times for the two series may be regarded as practically identical, and the variations as due to chance.

Between these extremes lie the results from the metronome, which show the effects of inhibition, facilitation, and habituation, and which may all be explained in the above manner.

Summary and Conclusion

1. The effect of 'distraction' upon the sensory reaction is equivocal. The distractor may inhibit, and lengthen the reaction; it may facilitate, and shorten the reaction; or it may become habitual, and have no effect at all.

2. The effect of the distraction is dependent:

a. upon the temporal relations of the distractor, and

b. upon the conscious attitude of the observer during the distraction.

3. The distractor most resistant to habituation is the intermittent; that least resistant is the continuous.

4. The passive attitude is conducive to a constant sensory reaction of normal length; the active attitude to a slow and variable reaction.

In the light of these results we can largely understand the lack of agreement among previous investigators of the effect of distraction. Distractors of different temporal character have been employed; and, what is still more significant, the observers' attitude has not been standardized, so that their reactions were made under various dispositions. That the importance of the conscious attitude in this connection has not been earlier detected, we believe to be due to the fallacy of conclusions based upon gross averages.